ATTACHMENT W

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Abstract

Non-Statistical Habitat Predictions Using Digital Aerial Photography and Relative Abundance of American Otter (*Lutra canadensis*) in the Apostle Islands National Lakeshore and Bad River Reservation, Wisconsin

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Interior open water bodies, predominately created by beaver (*Castor canadensis*), in the Apostle Islands National Lakeshore (Lakeshore) are more euthrophic environments than the Lake Superior shoreline, and hypothetically should provide richer foraging habitat for American otter (*Lutra canadensis*). Aerial survey data from 1992 through 2003 showed that Outer Island beaver colonies declined from 30 to three colonies. Beaver have been extirpated from Stockton Island since 1994. Rectification of small format digital aerial photographs taken in 2003 of Outer Island noted a 39% decline (115 acres to 70 acres) in open water since 1992, paralleling the decline in beaver colonies. Aerial slide surveys from 1999-2003 in the Lakeshore noted the presence of otter slide sign in association with lagoons, active and abandoned beaver flowages on Stockton, Outer, Michigan and Sand Islands. Islands within the Lakeshore without interior open water bodies did not have otter slide sign. The predation of beaver by black bear (*Ursus americanus*) coupled with poor habitat conditions was suggested for the extirpation of beaver on Stockton Island (Smith, 1994). Bear predation of beaver was also noted in 2000 in this study on Outer Island. The decline of beaver, and the subsequent availability of open water habitat on Outer and Stockton Islands may affect future otter populations. Both islands previously had the most stable beaver populations, especially Outer Island (post 1992), and provided the most open water habitat within the Lakeshore. The adjacent Bad River Reservation has 2,601 acres of open water bodies embedded in a land base dominated by young successional stage forests, large coastal wetlands and over 120 km of rivers on the Lake Superior mainland. The Reservation had abundant otter slide sign (one slide/ 7.2 km^2) throughout its land base, and aerial slide data noted otter slide sign in each coastal wetland and active beaver colony in a south to north gradient ending on the northern tip of Outer Island. The data suggested adequate colonization potential from the mainland, considering the large dispersal range of juvenile otter. Distributional data from aerial surveys also suggest otter population stability within the Lakeshore. In addition, otter densities within the Lakeshore are likely naturally limited by the small surface areas of the islands relative to otter home ranges as reported in the literature. The only anthropogenic stressor on the otter population was noted in the Bad River Reservation, where otter had elevated total mercury levels (mean 15 ppm wet weight) from hair samples. This was the highest recorded total mercury level noted in a Wisconsin otter population. Even though this level is relatively high, it is likely not population limiting.

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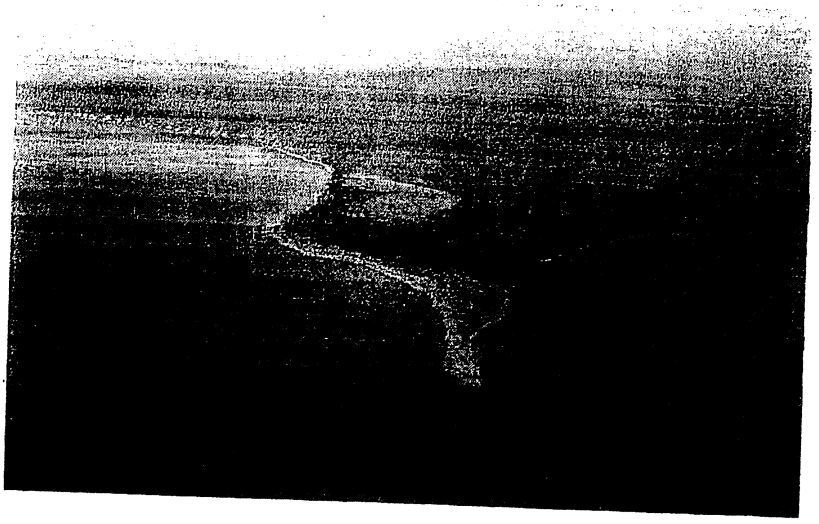

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Introduction

The study was initiated in 1997 on the Bad River Reservation and in 1999 on the adjacent Apostle Islands National Lakeshore. Formal funding was not secured through the National Park Service until March of 2000. The purpose of the study was to determine a relative abundance of otter, and provide methods of monitoring otter populations within both jurisdictions. Later in the study process, after noting a paucity of interior open water habitat possibly related to the decline of beaver on Outer Island; the study was expanded to provide a habitat monitoring method tracking the surface area of available open water on the Apostle Islands, using Outer Island as a template.

The American otter is one of nine species of *Lutrinae* globally (Davis, 1978), while Corbet and Hill (1980) recognized 13 species. The American otter (*Lutra canadensis*) originally ranged from arctic Alaska at a latitude of about 70^0 (Magoun and Valkenburg, 1977) to the southern states of Florida and Texas. This range substantially contracted starting about 1850, where otter were absent in 11 states and rare in 13. Habitat destruction, unregulated trapping and water pollution have been noted as reasons for range contraction, especially in the interior states (Jenkins, 1983). Restoration efforts through reintroductions have occurred in Illinois, Colorado, New York, Tennessee, Indiana, Ohio and Pennsylvania (Bishop et al., 1999; Bluett et al., 1999; Dwyer, 2000; Johnson and Berkley, 1999; Johnson and Madej, 1994). Presently, much of otter's former range in the Midwest and within the Great Lakes has been restored, but many southern and eastern Great Lake populations have not recovered (Doolittle, 2002).

River otter (*Lutra canadensis*) are relatively visible, use a variety of river, wetland and coastal habitats, and usually occur at low densities (Mason and Macdonald, 1986). Otter are common throughout most wetland, lacustrine and riverine systems throughout northern Wisconsin and the adjacent upper peninsula of Michigan (Wisconsin Department of Natural Resources, 1979-1999, Michigan Department of Natural Resources, 2000). In the literature, otter were first noted on the Apostle Islands on Oak, Stockton and Outer Islands (Jackson, 1961). Unconfirmed records occur from 13 of 22 Apostle Islands (Apostle Islands National Lakeshore, Resource Management Files). Prior to 1850 otter were a common element in the region, and were exploited for their fur prior to exploitation of beaver (Schorger, 1970). Otter are sensitive to various forms of pollution, and can be used as a bio-sentinel of environmental health. They are listed as a State of the Great Lakes Ecosystem Conference (SOLEC) indicator (#8147, U.S. EPA and Environment Canada, 2002). The SOLEC process suggests that the monitoring of otter will be especially useful to gauge potential bio-accumulative effects in local areas of concern (i.e. paper sludge sites), as well as being an indicator of possible food chain links that may affect human health (Doolittle, 2002, Appendix 1 A.). River otter are a furbearer harvested within the Bad River Reservation and the Apostle Islands by tribal and non-members. Otter (Niigig) have rich cultural ties to the Anishinabe people. In addition, otter as a top predator related to the aquatic food chain, are representative of environmental health of the Bad River watershed, Apostle Islands National Lakeshore and the Great Lakes St. Lawrence basin watersheds.

Study Objectives (Long Term)

1. Determine long-term trends in population abundance of otter in the Bad River Reservation and the Apostle Islands National Lakeshore.

2. Use otter as bio-sentinel to measure contaminant burdens, which would be compared to other samples collected in the Great Lakes St. Lawrence basin.
3. Network with other otter researchers in the Great Lakes St. Lawrence basin and to enhance local and regional bio-monitoring programs.
4. Create an otter population monitoring program to assist furbearer management on the Bad River Reservation and the Apostle Islands.
5. Assist in compiling data for creating an otter habitat suitability predictor on the Apostle Islands and the Bad River Reservation using low- level small format digital photography.
6. Define food habits, habitat uses and movements of otter on the reservation and the Apostle Islands.

Study Areas

The Apostle Islands National Lakeshore is located off the tip of northwestern Wisconsin's Bayfield peninsula (Figure 1.). The National Park Service has jurisdiction over 21 of the 22 islands. This archipelago juts outward approximately 48 kilometers into Lake Superior. The land area within National Lakeshore boundaries is 171 km^2, including a 19.3 km linear mainland segment. Madeline Island (the largest of the Apostle Islands) is not managed by the National Park Service but was included in the study as part of the Apostle Islands. The Apostle Islands study area is 219 km^2 and the total shoreline length of the 22 Apostle Islands is 310.2 km. The area is at or near the convergence point of two continental biomes. They are hemlock/hardwood forest and circumpolar boreal forest (National Park Service, 1989).

Most the historic forested uplands of the Lakeshore could be characterized as a hemlock-pine hardwood forest type (Beals and Cottam, 1960). The islands were periodically logged off starting after 1870 and ending in the early 1930's. The search for white pine started in the 1880's and most merchantable pine was gone by 1900. However, parts of Outer Island's north end were not logged off until the early1960's. Presently, the only virgin stand remaining on Outer Island was on the former federal lighthouse reserve property. The harvesting of hemlock bark for tanneries, cutting of fuel for steamboats, the use of pine and oak for fish barrels, and the clearing of forest lands for agriculture drastically changed the forest vegetation of the islands (Rakestraw, et al., 1976). The creation of the younger successional stage forest due to logging activity and subsequent fires encouraged the expansion of white-tailed deer (*Odocoleius virginianus*) into the Apostle Islands. Deer have impacts that directly manipulated forest regeneration, shrub and ground vegetation on most Apostle Islands (Beals and Cottam, 1960). Today, much of the forest has matured and deer are absent from most islands. Deer populations are presently located on Oak, Sand, Basswood, Long and Madeline Islands (Apostle Islands National Lakeshore, Resource Management Files, 2003). No logging activity has occurred within the Apostle Islands National Lakeshore since its inception on September 26, 1970.

The 125,000- acre (505.8 km^2) Bad River Reservation is located in parts of Ashland and Iron Counties on the south Shore of Lake Superior in northern Wisconsin. Approximately 77% of the reservation is forest, 11% consists of wetlands, and the remainder is agricultural land, residential communities and roads. The reservation has around 40 miles of Lake Superior Shoreline, and over 100 miles of navigable rivers and streams flowing into Lake Superior via the Bad, White and Kakagon Rivers. Approximately 200 acres of reservation land are on Madeline Island, which

and rearing her next litter of cubs and otter disperse great distances (Melquist and Hornocker, 1983). Subsequently, since mainland populations are stable, re-colonization potentials remain at levels that are likely higher than pre-1850 levels as the Apostle Islands exhibit classic species population fluxes of isolated island environments.

In 1998, heavy metal analyses noted that all eight otter from the Bad and White River systems had elevated total Hg concentrations in their hair in comparison to other Wisconsin Hg samples (N=49) in otter that averaged 6.47 ppm wet weight (Sheffy and St Amant, 1982). The control otter (sample ott-10) had levels comparable to other Wisconsin interior otter (5.5 ppm wet weight). (Dry (DW) and wet weight (WW) means for Reservation otter (N=8) were 18.45 ppm and 15.01 respectively (Table 2.). The greatest concentrations were 30.07 ppm (DW) and 22.1 ppm (WW). The one mink hair sample also tested high at 13.0 ppm (WW) (Doolittle, 1998). In Voyageurs National Park otters (N=5) in their fur had a range of 7.5 ppm to 75.0 ppm total Hg (WW). The otter with a hair concentration of 75 ppm was the highest Hg level ever recorded in a North American otter (Route and Peterson, 1988). Sheffy and Amant (1982) suggest that otters with Hg concentrations of 83.5 ppm in their hair could be near death. Effects of sub-lethal concentrations of toxic substance may be difficult to measure (Wren, 1991). Mason et al., 1986 has attributed Hg contamination to otter population declines in Great Britain and Sweden.

Table2. Total mercury (Hg) levels in otter hair samples (N=9)

Location	Sample No.	Hg Dry Wt.	Hg Wet Wt.
Vilas County, Wi	Ott-10	16.8	5.36
Ashland County, Wi	Ott-111	14.1	12.6
Ashland County, Wi	Ott-131	12.8	11.8
Ashland County, Wi	Ott-160	15.6	13.3
Ashland County, Wi	Ott-168	9.48	7.96
Ashland County, Wi	Ott-363	25.1	22.1
Ashland County, Wi	Ott-393	30.7	17.0
Ashland County, Wi	Ott-423	20.2	18.6
Ashland County, Wi	Ott-452	19.6	17.4
Means		18.45	15.01

Reservation-wide sediment and surface water Hg analysis noted non-detects for all surface water and sediment samples (Bad River Natural Resource Files, 1998). One potential known source of Hg in the Bad River Reservation and throughout the Great Lakes may be from sea lamprey (*Pteromyzon marinus*). Direct observations of two otters from a radioed sub-group of seven were observed feeding on sea lamprey in May 1998 near Bad River Falls within the Reservation. In Hg analysis of whole lamprey (N=12) collected during the spring spawning run in the Bad River, mean concentrations (WW) were 2.7 ppm (Fisheries and Ocean Canada, 1998). Other supporting data from Fisheries and Oceans Canada (1998) testing muscle tissue found 1.3 ppm WW from north shore streams on Lake Superior. Larval and transforming lamprey from the Bad River did not have detectable levels of mercury suggesting primary loads were attained as parasitic adults. O'Connor and Nielson (1981) concluded that a regular dietary intake of food containing 2 ppm Hg would prove lethal to otters in the wild. Deaths in mink receiving a dietary intake of 1.8 ppm

Hg have been recorded (Wobeser et al., 1976). Subsequently, the potential of sub-lethal or even lethal effects of Hg in food items (eg. sea lamprey) could subtly reduce otter populations on the Reservation (Doolittle, 1998). In review of the literature, even though the Hg levels were the highest mercury levels found in a Wisconsin otter population, were not at critical thresholds that were suggested to affect overall otter populations (Wren, 1991; Mason and Macdonald, 1986; Sheffy and St. Amant, 1982; Halbrook et al., 1981).

The organic pesticides detected in otter fat tissues were DDE (metabolite of DDT), Lindane, Dieldrin, and Heptachlorepoxide. One male had the greatest body burdens of DDE and dioxin/furans. Dioxins/ furans were found in all eight otters with the lowest values in the otter from the most upstream site (Table 3.). Dioxin/furan and congener specific PCB analyses were inconclusive due to high detection limits because of the small samples submitted (0.5g-23g) for analysis. Future samples should be larger (> 30g) which should be collected from dead individuals to bring detection limits down to 1.0 ppt to ascertain critical thresholds of specific dioxin/furan congeners, especially the TCDD's and PCB's. Interpretation of furan values is still under review due to the detection of diphenyl ethers that may have influenced the actual values for the furans. All furan values were considered as an estimated maximum possible concentration (EMPC) for a specific congener, since diphenyl ethers can produce false positives for chlorinated dibenzofurans. Little is known about the biological effects of polychlorinated diphenyl ethers, but their dynamics and persistence in animal tissues are similar to that of the PCB's (Jones et al., 1993). When EMPC values were used in a toxicity equivalency factor for comparisons of levels known to cause reproductive failure in mink, one of eight otters exceeded the effect threshold (Doolittle, 1998).

Table3. Results of detected standard pesticides found in eight river otters

Pesticide	Range (ppb)	% Occurrence	Mean (ppb)
DDE	0-1600	(4) 50	346
Heptachlorepoxide	0-220	(2) 25	45
Dieldrin	0-100	(1) 12.5	12.5
Alpha BHC	0-470	(2) 25	89
Beta BHC	0-270	(1) 12.5	34
Lindane	0-230	(2) 25	51

The toxicity of planar chlorinated hydrocarbons (PCHs), which include polychlorinated biphenyls (PCBs) and their effect on reproduction in mink, is well documented (Hornshaw et al, 1983; Ringer et al., 1981; Aulerich et al., 1987; and Shull et al., 1982). Mink are one of the most sensitive mammals to these anthropogenic toxic chemicals. River otters are likely surrogates to mink, but less research has been conducted. Studies in Sweden and Great Britain show a marked decline in Eurasian otters (*Lutra lutra*) due to effects of PCBs and other organochlorines (Mason et al., 1986). The river otter's population within the Great Lakes St Lawrence basin has been